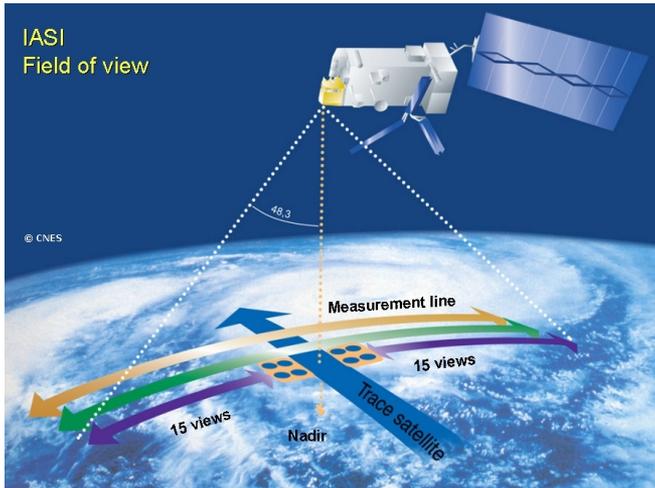
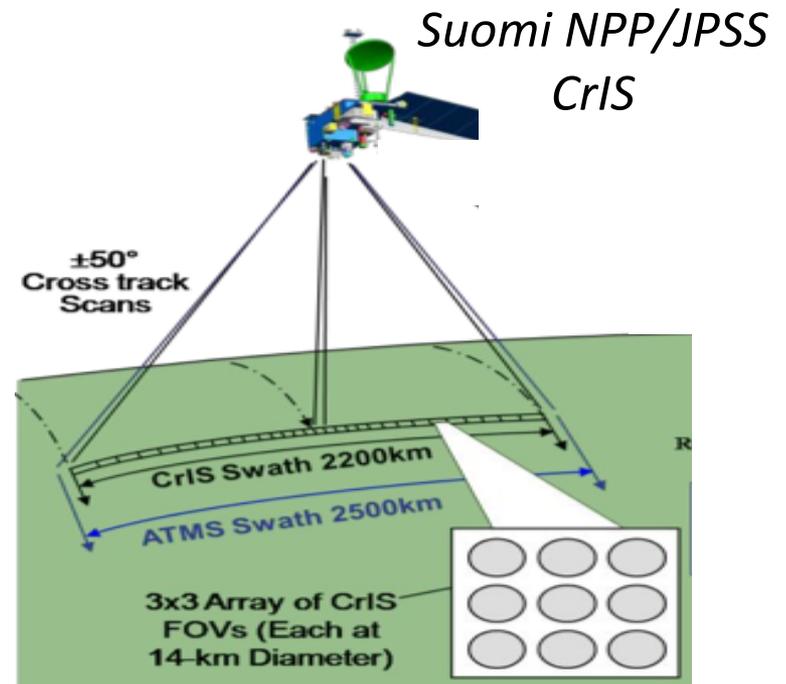
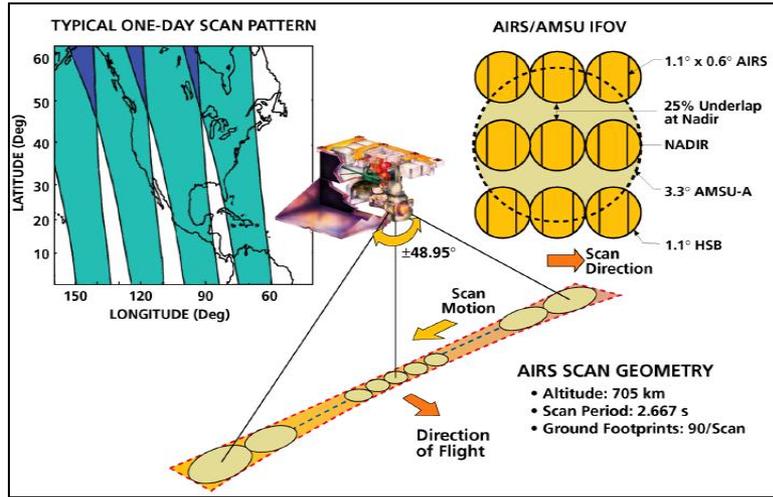


Cross-Validation of Climate Products from AIRS, IASI, and CrIS - Making the Case for CLARREO

W. Smith, N. Smith, E. Weisz, and H. Revercomb



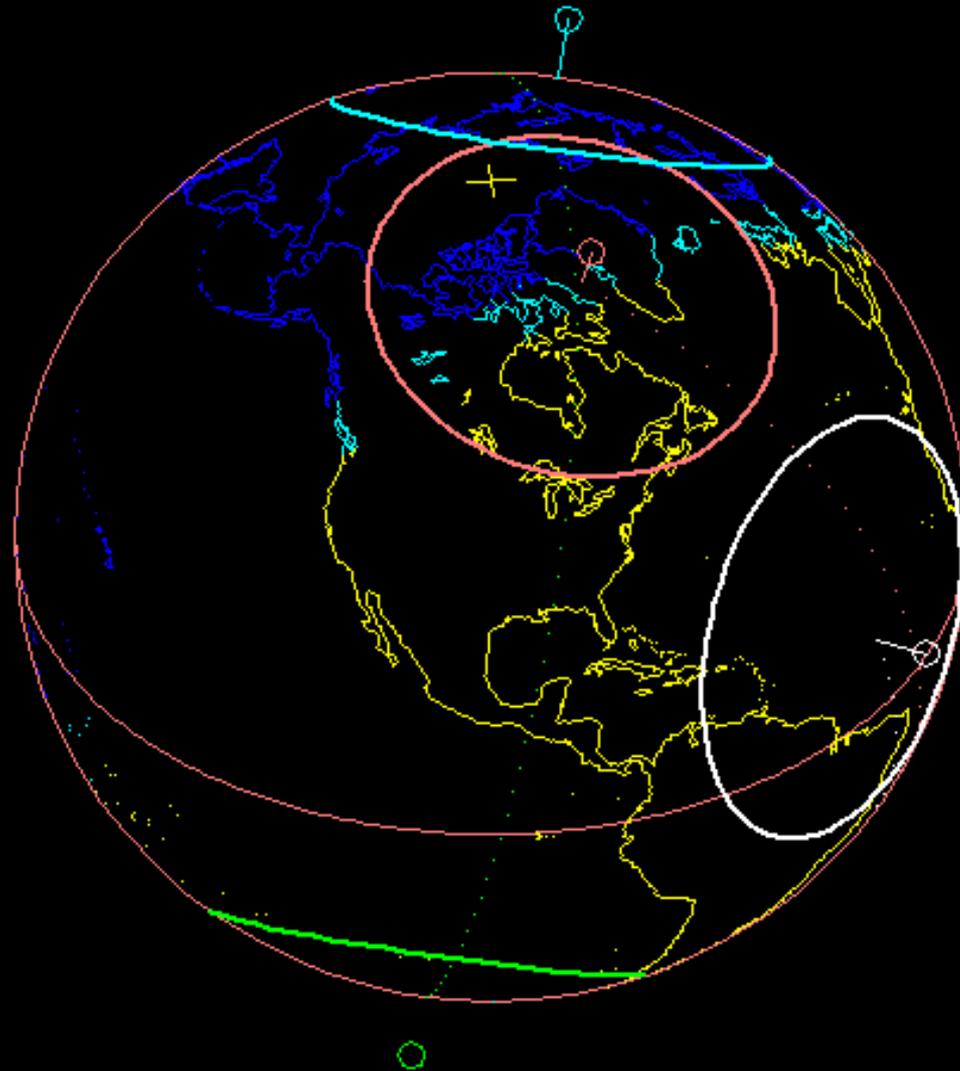
CLARREO SDT Meeting

NASA Goddard Space Flight Center, January 7-9, 2014

Ultra-spectral Measurement Characteristics

Satellite	Instrument	Spatial resolution	Spectral resolution	Spectral Range	Spatial Sampling
Aqua (1330 LST)	AIRS (2002 -)	3x3 13.5-km (50 km)	~1200 resolving power	645-2700 cm^{-1}	Contiguous Cross-track scan
Metop-A/B (0930 LST)	IASI (2006 -)	2x2 12.0-km (50 km)	0.25 cm^{-1}	645-2760 cm^{-1}	Contiguous Cross-track Scan
SNPP (1330 LST)	CrIS (2011 -)	3 x 3 13-km (50 km)	0.6 cm^{-1}	645-2700 cm^{-1}	Contiguous Cross-track Scan
CLARREO Polar (All LST)	IR-SW/MW	25-100 km (TBD)	0.5 cm^{-1}	200-2700 cm^{-1}	Nadir

NPP	13365.5221	7202.25	98.77	101.44	824.25
AQUA	13365.5111	7077.72	98.22	98.83	699.72
METOP-A	13345.4909	7195.62	98.69	101.30	817.62
METOP-B	13151.7275	7195.62	98.70	101.30	817.62



METEOROLOGICAL SATELLITES

16:07 UT

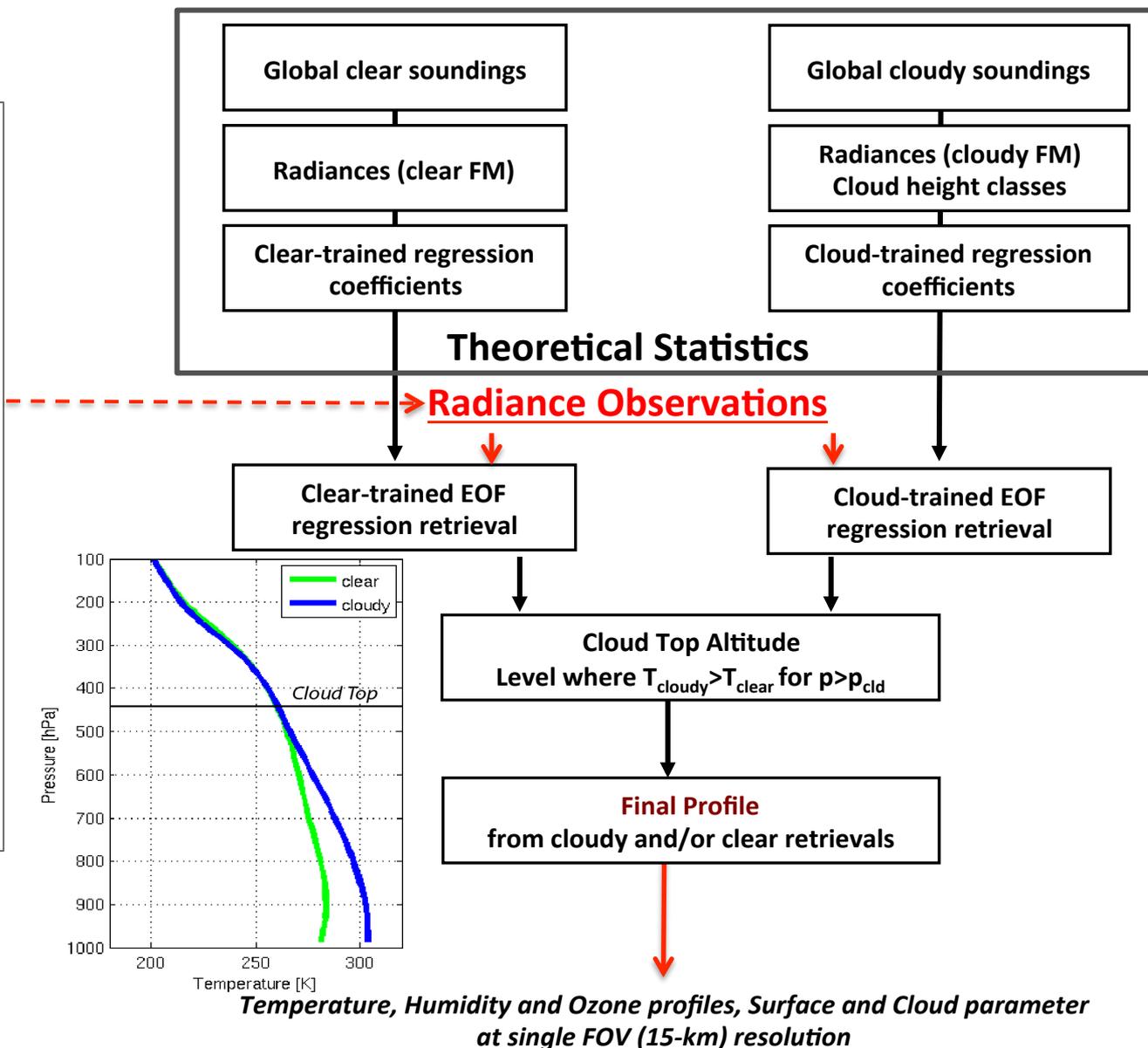
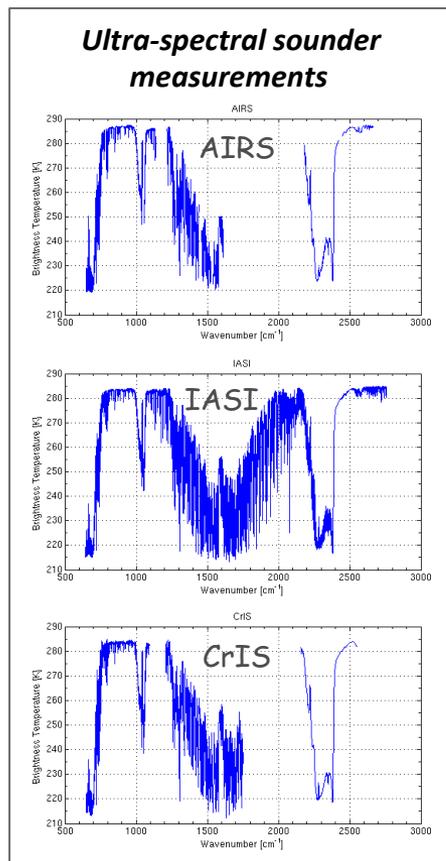
3 JAN 14

CLARREO - State Parameter Climate Retrieval Monitoring Climate Change from Polar Soundings

Desirable Features of a Climate Variable Retrieval Algorithm:

- ***Linear dependence on radiance spectra***
 - Variation depends only on radiance (i.e., no other input variables)
- ***All sky***
 - clear and cloudy (clear air in cloudy FOV)
- ***Independent of Field-of-View (FOV) size***
 - Can be applied to different instruments
- ***Retrieval Variables***
 - Surface : temperature & spectral emissivity
 - Atmosphere : T, H₂O, and O₃ profiles & CO₂ ppm
 - Cloud : height and optical thickness
- ***Monthly Means Produced within Ten Degree Grid Cells***

“Dual-Regression” Retrieval Algorithm* Overview



* Smith, W. L., E. Weisz, S. Kirev, D. K. Zhou, Z. Li, and E. E. Borbas (2012), Dual-Regression Retrieval Algorithm for Real-Time Processing of Satellite Ultraspectral Radiances. *J. Appl. Meteor. Clim.*, 51, Issue 8, 1455-1476.

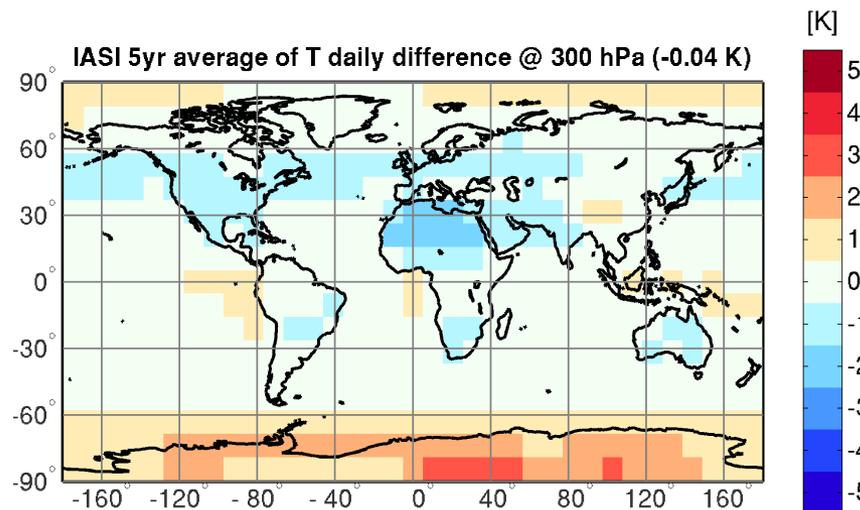
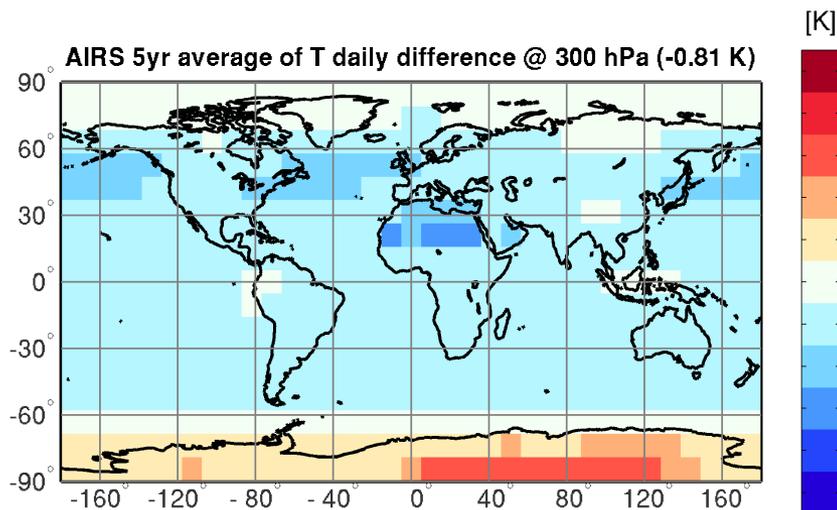
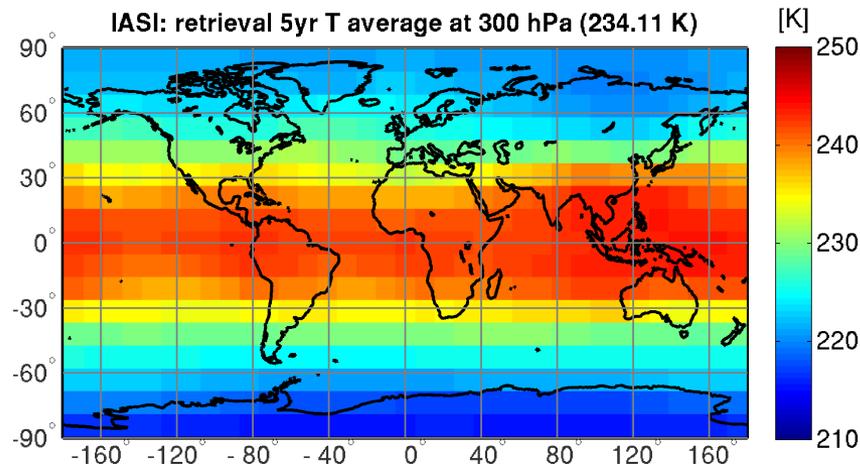
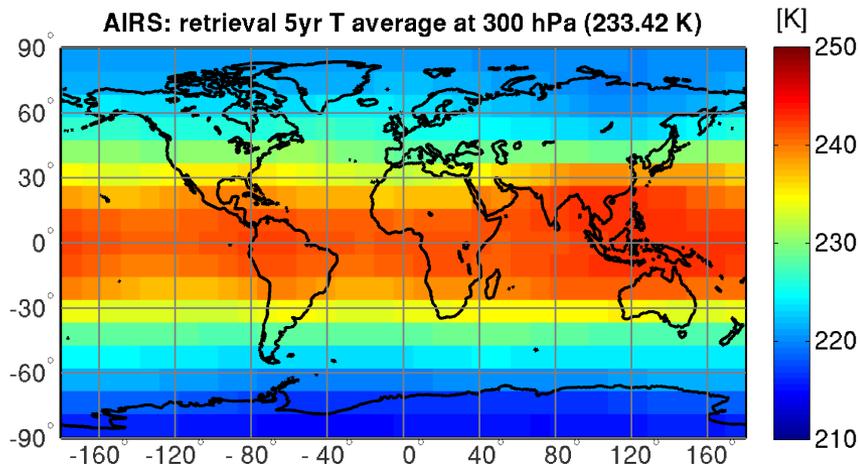
* Weisz, E., W. L. Smith Sr., and N. Smith (2013), Advances in simultaneous atmospheric profile and cloud parameter regression based retrieval from high-spectral resolution radiance measurements, *J. Geophys. Res. Atmos.*, 118, 6433–6443

5-yr Mean (2008–2012)* 300 hPa Temperature

AIRS vs IASI

13:30 LST

09:30 LST



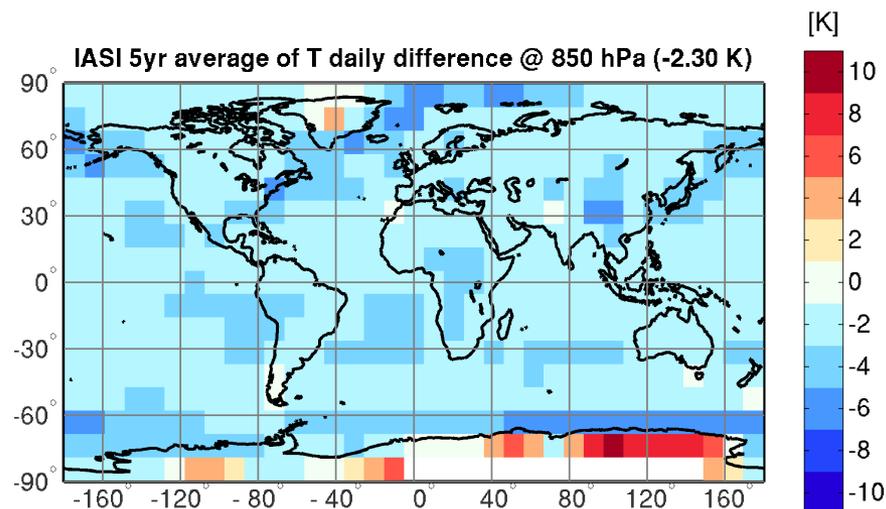
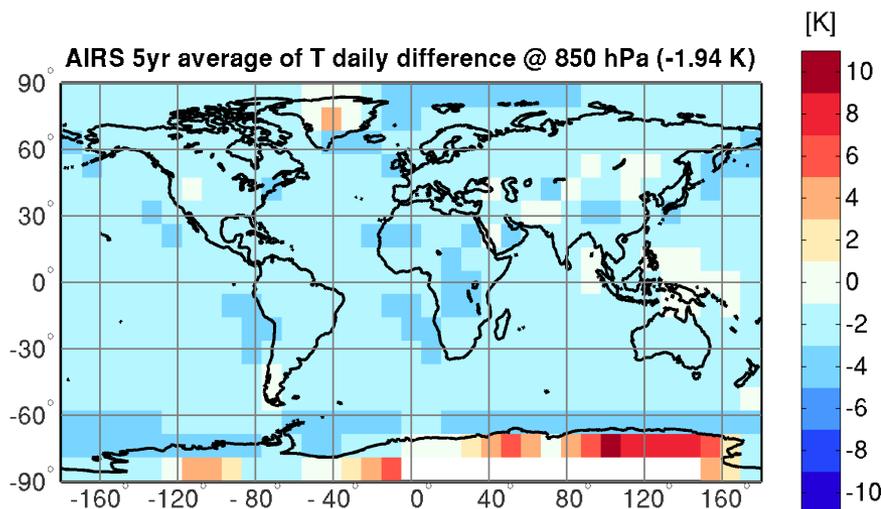
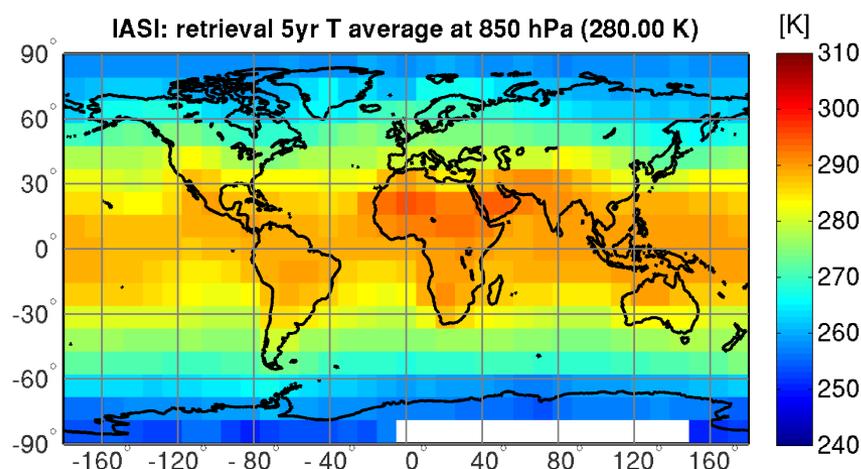
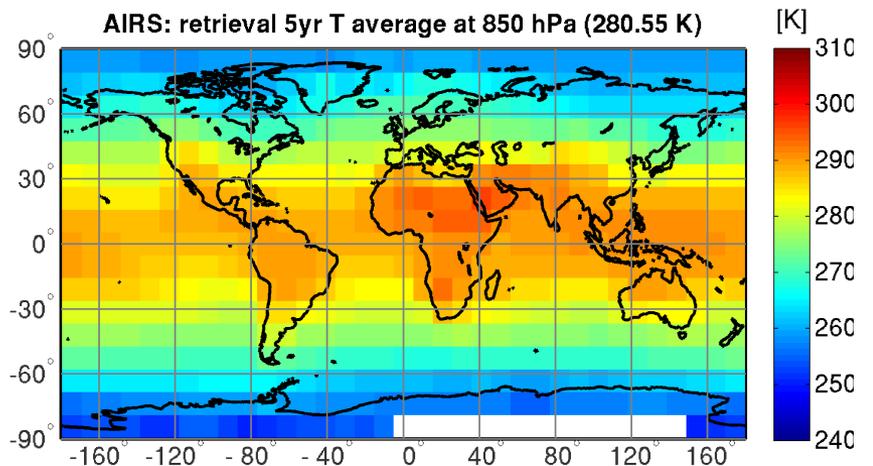
**Four months per year (February, May, August, and November)*

5-yr Mean (2008–2012)* 850 hPa Temperature

AIRS vs IASI

13:30 LST

09:30 LST



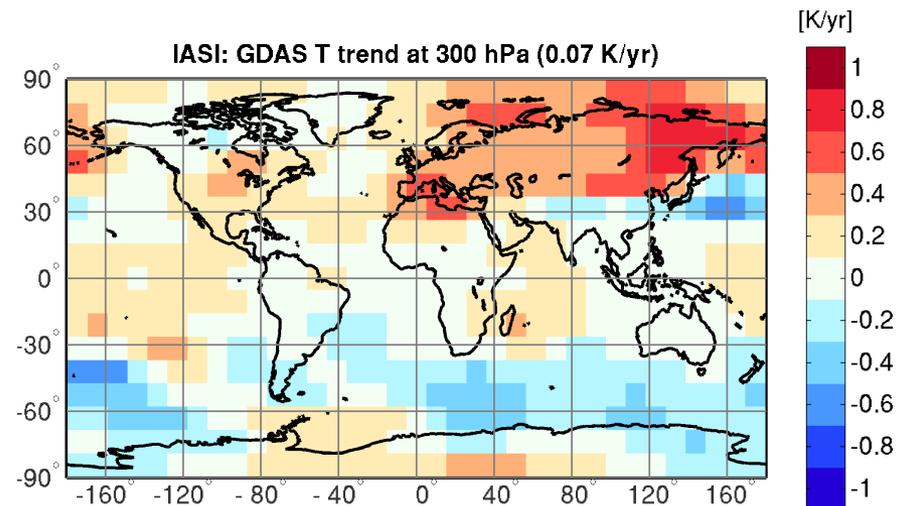
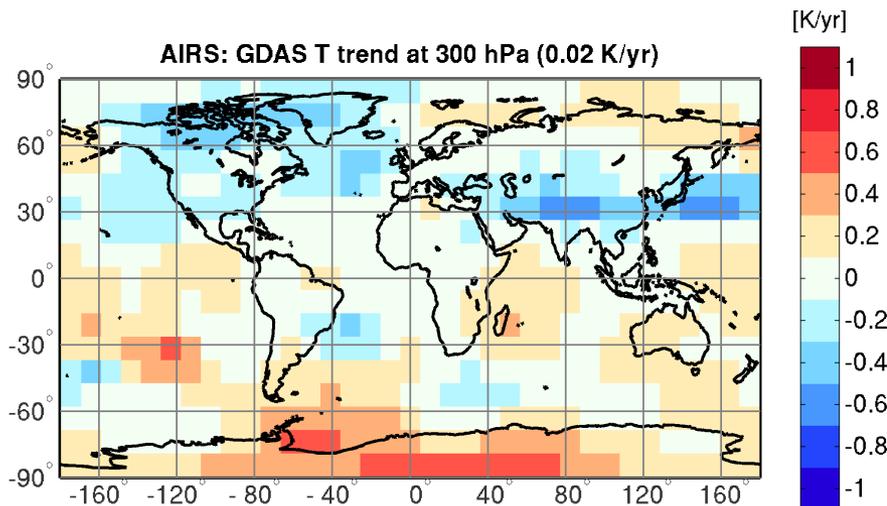
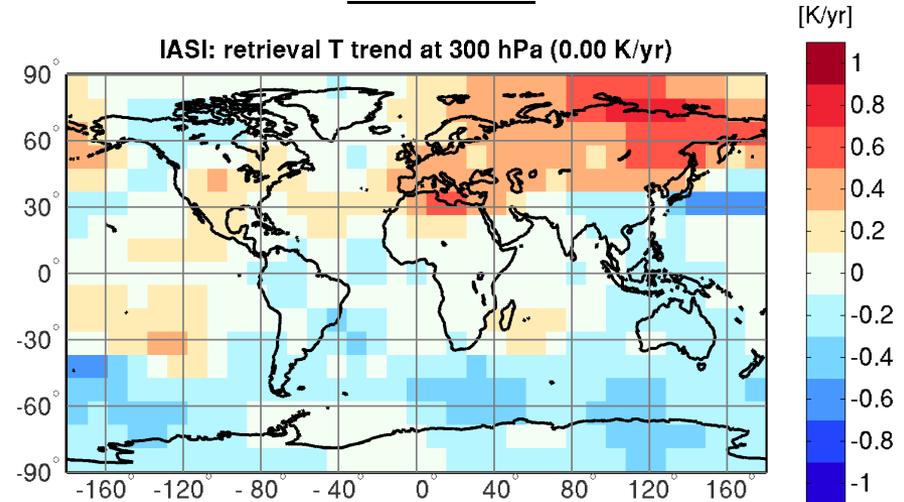
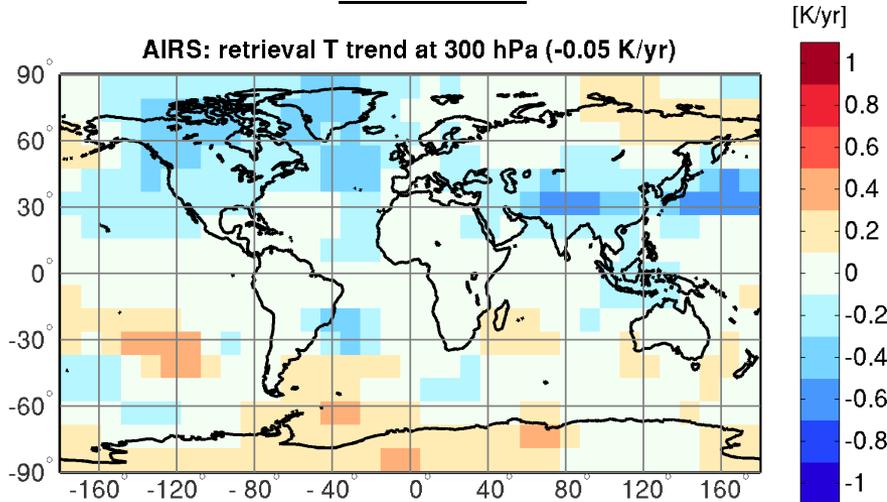
AIRS is 0.55 K warmer than IASI and 0.36 K being due to time difference

5-yr Trend (2008–2012) 300 hPa (K/yr)

AIRS vs IASI

13:30 LST

09:30 LST

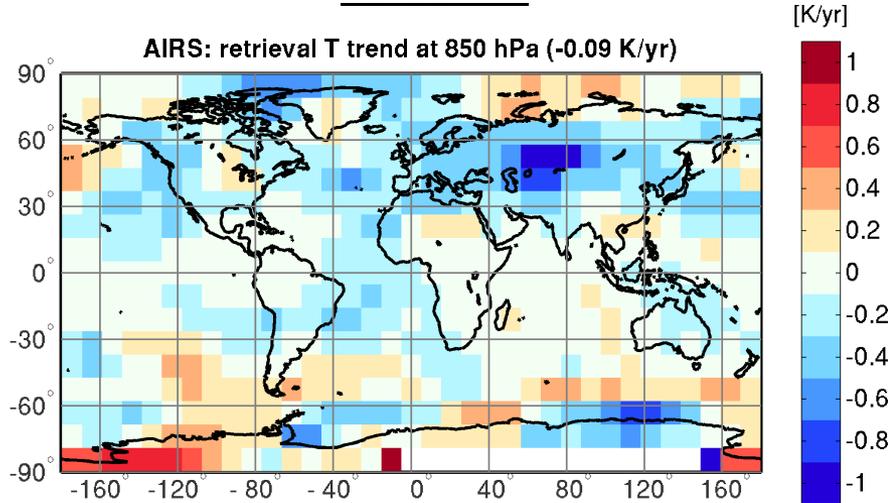


IASI-AIRS Trend difference is 0.05 K/yr while GDAS Trend time difference is 0.05 K/yr

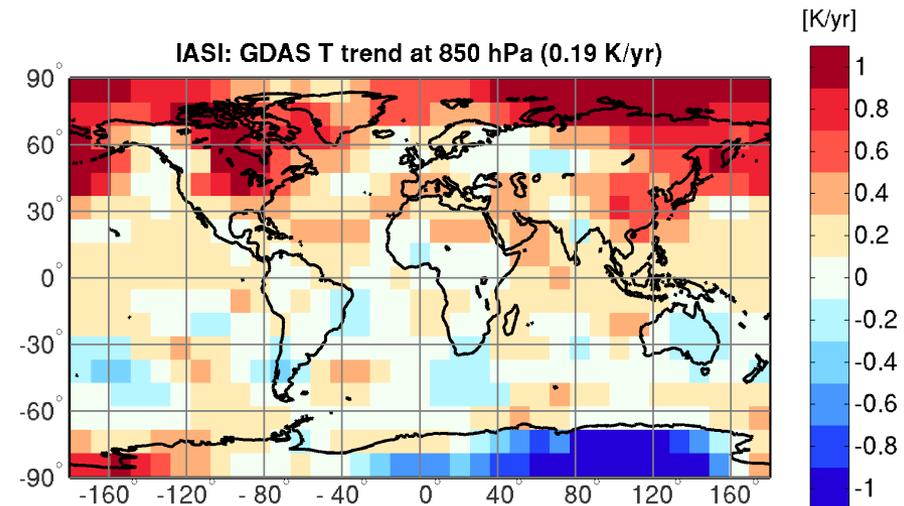
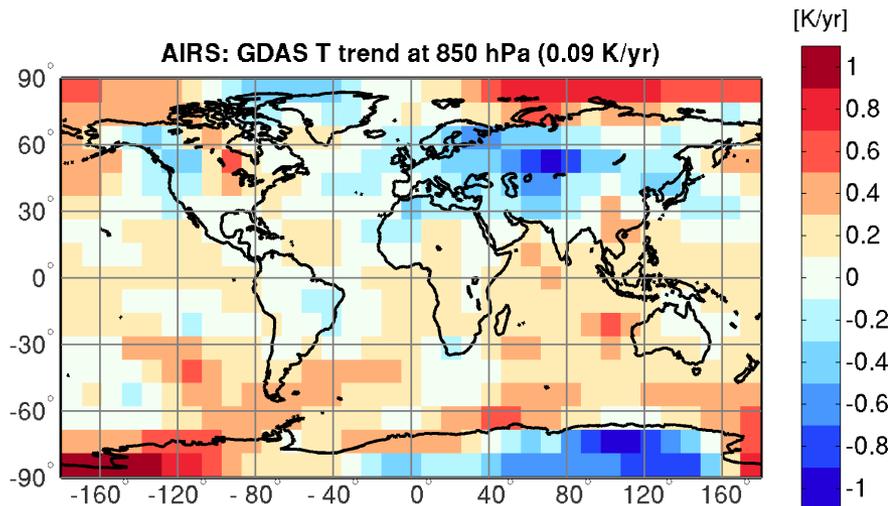
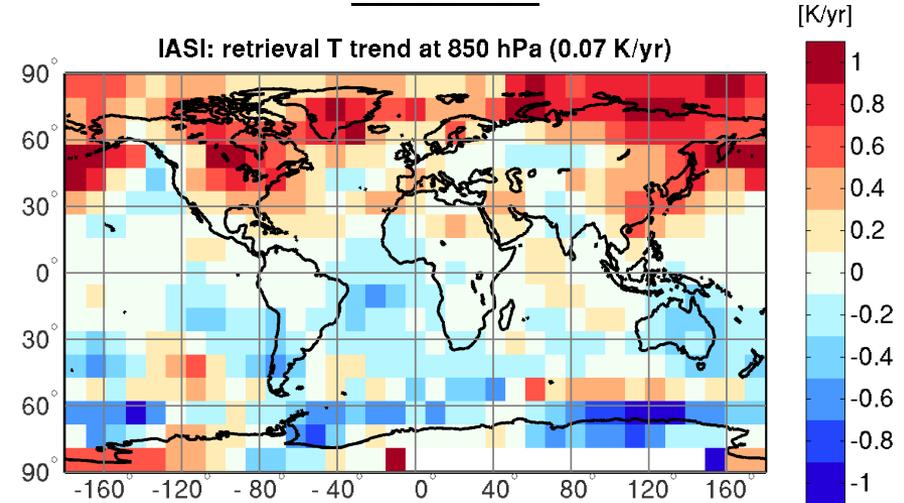
5-yr Trend (2008–2012) 850 hPa (K/yr)

AIRS vs IASI

13:30 LST



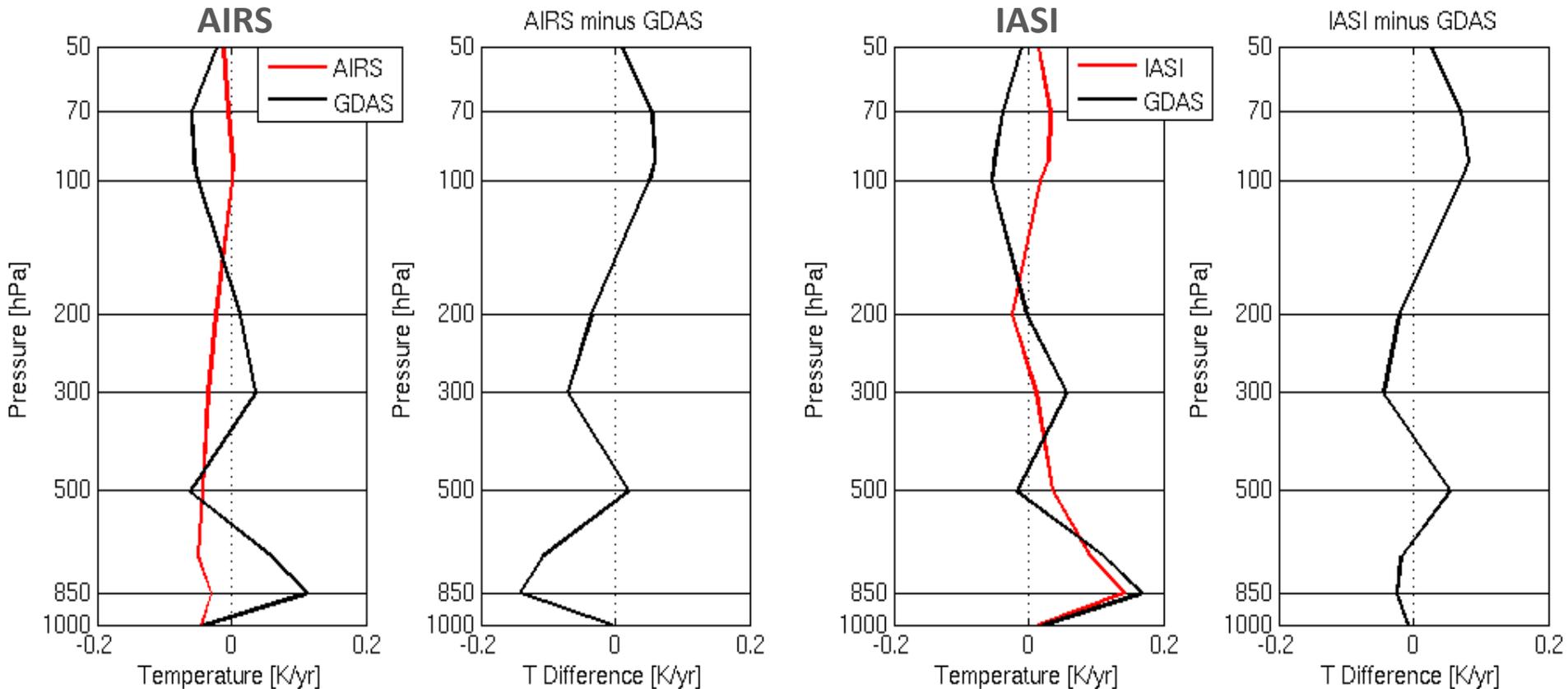
09:30 LST



IASI-AIRS Trend difference is 0.16 K/yr while GDAS Trend time difference is 0.10 K/yr

5-yr Trend (2008–2012)* Profiles (K/yr)

AIRS Vs IASI

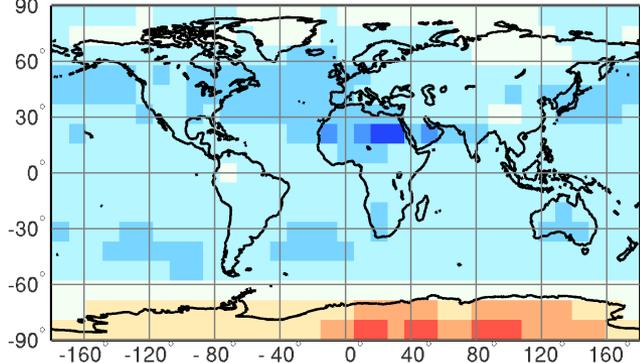


- ***IASI vertical temperature profile trend is in better agreement with GDAS than is the AIRS.***
- ***IASI shows typical CO₂ Greenhouse warming signature; AIRS shows tropospheric cooling.***
- ***GDAS global trends show little dependence on the IASI and AIRS sampling times.***

AIRS, CrIS and IASI – GDAS Annual Means (2012)

300 hPa

AIRS 1year average of T daily difference @ 300 hPa (-1.05 K)



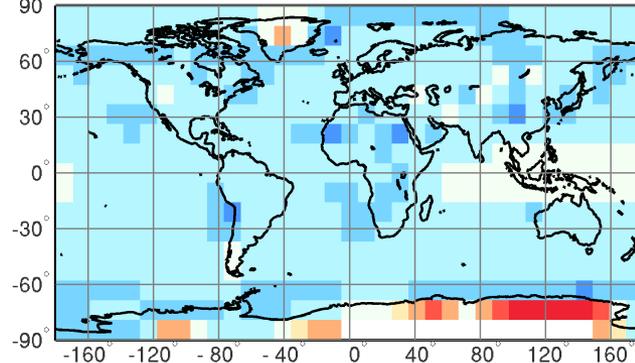
[K]



13:30
AIRS

850 hPa

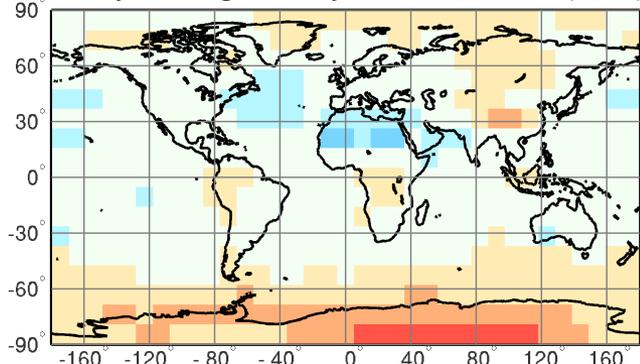
AIRS 1year average of T daily difference @ 850 hPa (-1.89 K)



[K]



CRIS 1year average of T daily difference @ 300 hPa (0.08 K)

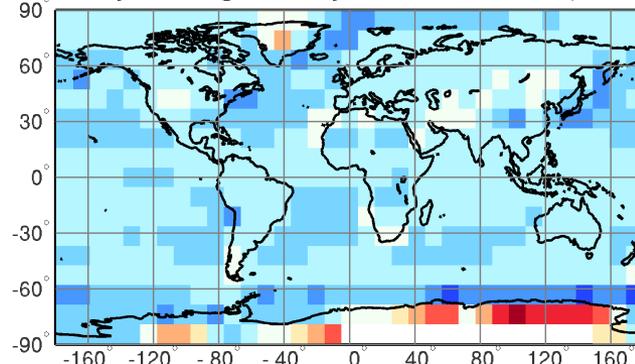


[K]



13:30
CrIS

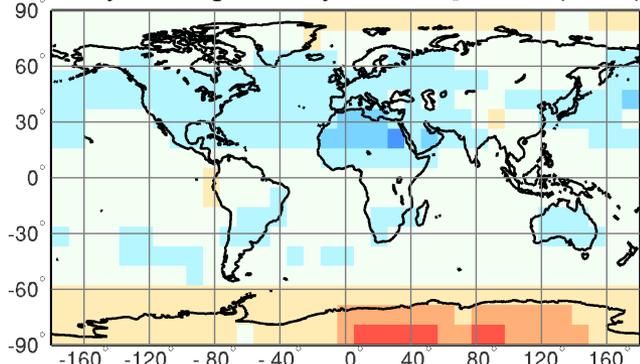
CRIS 1year average of T daily difference @ 850 hPa (-2.32 K)



[K]



IASI 1year average of T daily difference @ 300 hPa (-0.25 K)

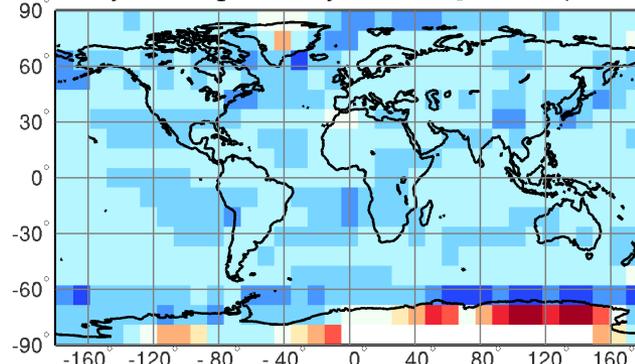


[K]



09:30
IASI

IASI 1year average of T daily difference @ 850 hPa (-2.54 K)



[K]



Summary and Conclusion

1. Dual Regression provides climate quality all sky condition retrievals from current hyperspectral sensors
2. 5-yr statistics show that AIRS differs from IASI by - 0.7 K at 850HPA and +0.34 K at 850 hPa. Co-located GDAS profiles indicate that 50 % of this difference is due to time difference.
3. IASI-AIRS Trend difference is ~ 0.05 K/yr while space and time co-located GDAS Trend time difference is ~ 0.02 K/yr
4. IASI vertical temperature profile trend is in better agreement with GDAS than is the AIRS vertical temperature profile trend
5. IASI and GDAS show typical CO₂ greenhouse warming signature; AIRS shows slight tropospheric cooling.
6. GDAS global trends show little dependence on the IASI and AIRS sampling times.
7. IASI and CrIS agree with each other better than either agrees with AIRS, indicating an instrument technology dependence
8. Need CLARREO to cross-calibrate satellites in orbit in order to eliminate instrument dependent climate variable biases
9. Publication in preparation: “ Comparison of AIRS, IASI, and CrIS Soundings – making the case for CLARREO ” Smith, Nadia, W. Smith Sr., E. Weisz, H. Revercomb, JCAM.